

**Incidence of Parasitic Infestation of Cattle in Kuku Dairy Herds,
Khartoum State, Sudan**

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**A Thesis Submitted to the University of Khartoum in Partial
Fulfillment of the Degree of Master of Tropical Animal Health,
(M. T. A. H.)**

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December 2005

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

وَإِنَّ لَكُمْ فِي الْأَنْعَامِ لَعِبْرَةً نُّسْقِيكُم مِّمَّا فِي بَطُونِهِ

مِنْ بَيْنِ فَرْثٍ وَدَمِ لَبَنٍ خَالِصًا سَائِغًا لِلشَّارِبِينَ

صدق الله

العظيم

سورة النحل الآية 66

DEDICATION

TO

THE SOUL OF MY MOTHER AND FATHER

MY BROTHERS AND SISTERS

MY FRIENDS AND COLLEAGUES

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ACKNOWLEDGEMENT

Thanks first and last to Allah, who gave me the health, strength and patience to finish this work.

My appreciations and best thanks to:

- Dr. Khitma Hassan El Malik for her keen supervision and valuable guidance.
- Dr. Ahmed Hussein A. Rahman for his encouragement and unlimited support.
- Dr. Atif Al Amin A. Gadir for data analysis and unlimited help.

- The staff of the Department of Preventive Medicine and Veterinary Public Health, especially Mr. Ahmed A. Wahid for technical help.
- My colleagues, especially Dr. Mohammed Siddig Al Arabi for helping me in samples collection.
- The owners of animals in Kuku area for allowing me to sample their animals.
- My brothers Fakhr Aldin, Hassan and Metwakil for the unlimited help and continuous support.

ABSTRACT

This was an investigation of blood and internal parasites in different seasons (dry cool, dry hot and wet hot seasons) in dairy herds in Kuku area of Khartoum State. The result showed that there was a high prevalence of blood parasites in the dry cool season (46%) compared to dry hot and wet hot seasons with a percentage of 14.74% and 5.68%, respectively. While the presence of internal parasite, was found to be less than blood parasites (15%, 8.42% and 11.36 for dry cool, dry hot and wet hot seasons, respectively). The prevalence of *Theileria* spp. infection was high in the dry cool and the dry hot season (39% and 14.74, respectively). While *Babesia* spp. infection was only recorded in the dry cool season (6%). Prevalence of *Schistosoma* spp. infection was high in the dry hot season (5.26%), while high prevalence of *Fasciola* spp. infection and *Coccidia* spp. infection were (7% and 6%) both recorded in the dry cool season.

A positive correlation ($\chi^2=48.483$, $P<0.01$) was found between season and presence of blood parasite. In contrast presence of internal parasites was not associated with season ($\chi^2= 2.058$, $P<0.05$).

Tick infestation was found statistically significant ($\chi^2= 20.583$, $P<0.01$) with respect to presence of blood parasites. However application of Odds Ratio indicated that tick infestation could be a risk factor (OR=3.586) for

presence of blood parasites. Also the age was found statistically significant ($\chi^2 = 6.211$, $P < 0.05$) but did not reach a level of risk factor.

Packed cell volume (PCV) was found to be strongly associated with both the presence of blood and internal parasites ($\chi^2 = 9.679$ and 6.573 , respectively). Odds ratio revealed that the PCV can reach the level of risk factor for both occurrences of blood and internal parasites (OR = 1.717 and 3.582, respectively).

الخلاصة

هذه الدراسة عبارة عن تقصي عن وجود طفيليات الدم والطفيليات الداخلية خلال فصول العام المختلفة (الفصل الجاف البارد، الفصل الجاف الحار والفصل الرطب الحار) في أبقار اللبن في منطقة كوكو في ولاية الخرطوم. أظهرت النتائج عن ارتفاع نسبة الإصابة بطفيليات الدم خلال الفصل الجاف البارد (46%) مقارنة بالفصل الجاف الحار والفصل الرطب الحار (74,14% و 5,68% على التوالي). بينما كان وجود الطفيليات الداخلية أقل من وجود طفيليات الدم (15%، 8,42% و 11,36% في الفصل الجاف البارد، الفصل الجاف الحار والفصل الرطب الحار على التوالي). نسبة الإصابة بطفيل الثاليريا كانت عالية في الفصل الجاف البارد والفصل الجاف الحار (39% و 14,74% على التوالي). بينما الإصابة بطفيل البابينزيا لم تسجل إلا في الفصل الجاف البارد (6%) فقط. نسبة الإصابة بطفيل الشستوسوما كانت عالية خلال الفصل الجاف الحار (5,26%)، بينما النسبة العالية للإصابة بطفيل الفاشيولا وطفيل الكوكسيديا (6% و 7% على التوالي) سجلت في الفصل الجاف البارد.

وجد أن هنالك علاقة بين التغيرات الفصلية و ظهور طفيليات الدم (مربع كاي = 48.483 ، قيمة $p > 0.001$). على النقيض ظهر أنه لا توجد علاقة بين فصول السنة و ظهور الطفيليات الداخلية (مربع كاي = 2.058 قيمة $p < 0.05$).

أظهرت الدراسة وجود علاقة بين وجود القراد و ظهور طفيليات الدم (مربع كاي = 20.583 و قيمة $p > 0.05$)، و بتطبيق (Odds ratio) وجد أن وجود القراد يمثل عامل خطر لظهور طفيليات الدم (Odds ratio = 3.586).

وجد أن هنالك تأثير لعمر الحيوان علي ظهور طفيليات الدم (مربع كاي = 6.211 و قيمة $p > 0.05$) لكنه لا يصل لدرجة أنه يمثل عامل خطر لظهور طفيليات الدم.

أظهرت الدراسة عن وجود تأثير قوي لظهور طفيليات الدم و الطفيليات الداخلية علي كبوس الدم (مربع كاي = 9.679 و 6.573 علي التوالي)، و تصل لدرجة أنها تمثل عامل خطر عليه (Odds ratio = 1.717 و 3.582 علي التوالي).

INTRODUCTION

Animal resources in the Sudan are considered as one of the largest in the Arab and African countries, and estimated according to the records of the Ministry of Animal Resources and Fisheries (2003) as 132,340,000 head including different species of sheep, goats, camels and cattle. Cattle played a significant role in the economic cycle in rural and urban areas, and estimated to be 39, 379,000 head distributed in different parts of Sudan. The population of cattle in Khartoum State constitutes 0.57%. The total population of cattle in Sudan distributed either within aggregation sites in different locations such as Kuku, Soba and Al-Rodwan areas; or in small herds located in different sites around the state.

The high needs for animal proteins especially milk and milk products in recent years in Khartoum State oriented the producers to import highly milk producing foreign breeds to face the human consumption, which had been increased recently as the result of human population increase as a result of urbanization and migration from other states. Also because the local breeds can not meet the demand of the markets due to their low productivity.

The high increase of crossbred cattle in blood and internal parasites endemic areas such as Kuku played an important role in dissemination of health problems due to the high susceptibility of foreign breeds to different causative agents. In addition, the bad husbandry and poor management in the farms complicated the health status of dairy cattle.

Kuku area represents a famous site of the dairy cattle aggregation, which suffered from different health problems especially parasitic diseases.

Other diseases are fairly under control by using vaccines or chemotherapeutic preparations. Parasitic diseases affect the milk industry by the direct effect on milk production, difficult control of vectors, high cost of the parasites treatment and financial implications for farms management to prevent the parasitic infestations. Studies on these diseases were limited, so the aim of this study is to achieve the following objectives:

- To study the prevalence of blood and internal parasites in dairy cattle during different seasons in Kuku area.
- To assess the relationship between the occurrence of blood and internal parasites and seasonal variation.
- To correlate the animals factors of breed, age and sex, clinical factor such as Packed Cell Volume and extent of tick infestation to the incidence of parasitic infection.

CHAPTER ONE

LITERATURE REVIEW

1. The parasites

1.1 Internal parasites

1.1.1 Description and classification

Internal parasites mainly belong to three major groups namely *Nematoda*, *Cestoda* and *Trematoda*.

1.1.1.1 Description and classification of Nematodes

The Nematodes are free living or parasitic un-segmented worms, usually cylindrical and elongated in shape. An alimentary tract is present-with a few exceptions, the sexes are separated and the life cycle might be direct or includes an intermediate host. A brief classification of Nematodes is adopted from Grove and Newell (1974) as follows:

Kingdom	<i>Animalia</i>
Subkingdom	<i>Metazoa</i>
Phylum	<i>Nemathelminthes</i>
Class	<i>Nematoda</i>

1.1.1.2 Description and classification of cestodes

Tape worms are hermaphrodite, endoparasitic worm with an elongate flat body without a body cavity or alimentary canal. They might be a few millimeters to several meters in length. The body consists of a head or scolex. Followed by short unsegmented portion called the neck and, in general, the remainder of the body consists of a number of segments which

are separated by transverse constriction, which vary considerably in shape and size. Each segment usually contains one or two sets of reproductive organs. A brief classification of cestodes as adopted from Soulsby (1982) is given below:

Kingdom	<i>Animalia</i>
Subkingdom	<i>Metazoa</i>
Phylum	<i>Platyhelminthes</i>
Class	<i>Cestoda</i>

1.1.1.3 Description and classification of Trematodes

The body of trematodes or flukes is dorsoventrally flattened, unsegmented and leaf-like. No body cavity is being present, suckers hooks or clamps attach adult stages of these species to the exterior or the internal organs of their hosts. A mouth and alimentary canal are present, but usually there is no anus. The reproductive system is hermaphrodite, except in the family *Echinostomatidae*. The life histories are direct (*Monogenea*) or in direct (*Digenea*).

A brief classification of trematodes is adopted from Grove and Newell (1974) as:

Kingdom	<i>Animalia</i>
Subkingdom	<i>Metazoa</i>
Phylum	<i>Platyhelminthes</i>
Class	<i>Trematoda</i>

1.1.2 Transmission of internal parasites

1.1.2.1 Transmission of nematodes

There are two types of transmission, direct or indirect transmission.

1.1.2.1.1 Direct transmission

In the transmission of nematodes which do not require an intermediate host, the eggs might hatch outside the host and the larvae are free living for a time e.g. *Strongylus* spp. The (infective stage) enter in to the host through the mouth. Also, the eggs may develop outside the host but do not hatch e.g. *Toxocara vitularum*, and larvae entered the host inside the egg through the mouth (Soulsby, 1982).

1.1.2.1.2 Indirect transmission

In case of *Metastrongylus*, sheep, pigs and deer are considered as definitive hosts, while the earth worms are considered as intermediate host. The transmission occurs when the intermediate host takes the larvae, then the intermediate host is eaten by the definitive host. Some times the eggs do not hatch such as in *Spiroradea* and is ingested by the intermediate host e.g. the house fly, which is eaten by the final host e.g. equines species. For *Filarioidea* the larvae enter the blood of the final host e.g. cats and dogs, by blood sucking vectors such as mosquitoes (Soulsby, 1982).

1.1.2.2 Transmission of cestodes

All cestodes are indirectly transmitted where they need one or more intermediate hosts, with the exception of *Hymenolepis nana* (Soulsby, 1982). The infection takes place when infective larvae (called

Metacestodes) enter the definitive host through ingesting the intermediate host or parts of it such as echinococcosis and taeniasis.

1.1.2.3 Transmission of trematodes

The eggs of *Digenea* are usually passed in the feces from the final host under suitable conditions (moisture and warmth), eggs can not withstand dessication. Hatching is controlled by light, temperature and salinity. Five larval stages may occur; miracidium, sporosyst, redia, cercaria and metacercaria. An intermediate host is a snail or a wide range of other invertebrates. Miracidia enter the intermediate host by penetration. Inside the snail, miracidia develop to sporocysts, which produce either daughter sporocysts or rediae (Soulsby, 1982). Cercaria leaves the snail actively or passively, which encysts on or in a second intermediate host or on vegetation. Metacercaria (the final stage) reaches the definitive host passively on contaminated herbage in water or in or on a second intermediate host.

In the family *Schistosomatidae* cercaria actively penetrate the skin of the definitive host. Millions of cercariae may be produced from a single miracidium. After swallows of metacercaria by the final host excystation occurs in the intestinal tract, and immature stage migrates to its predilection site.

1.1.3 Examples of important internal parasites

1.1.3.1 *Fasciola* species

The most important species of the genus are *F. hepatica* and *F. gigantica* which are generally similar. The final host of *Fasciola* species is

mammals, both ruminants and non ruminants; and its intermediate hosts are snails of the genus *Lymnea* (Dunn, 1978).

The eggs are laid in the bile ducts of the final host, passed down into the intestine and out through feces. The development to the miracidium stage occurs at 22— 26° C. during 9—14 days. After hatching miracidia start looking for snails of the genus *Lymnea* within 3 hours. Inside the infected snail they develop to sporocysts, Radiae and Cercariae which are set out as motile forms. Then Cercariae attach themselves to firm surfaces and encyst to form infective metacercariae (Dunn, 1978).

Fascioliasis is emerging as the most important helimenthiasis problem in many countries. Infection takes three forms; chronic, which is rarely fatal and occurs in cattle; acute, which is almost exclusive to sheep and fatal; and black disease occurring chiefly in sheep where the immediate cause of death is *Clostridium oedematiens*.

The annual report of Sudan veterinary services (SVS) (1948) reported Fasciolosis during the dry months of the year causing mortality among cattle, goat and sheep in the White Nile Province, and the report of 1953, 1954 stated that the incidence of Fascioliasis increased in the same area.

1.1.3.2 *Schistosoma* species

This family is primary parasitic in blood vessels of the alimentary tract and bladder. The genus *Schistosoma* differs from other flukes in that the sexes are separated. Many genera of water snails act as intermediate hosts e.g. *Bulinus* spp., *Eustralorbis* spp., *Oncomelania* spp. and *Biomphalaria* spp., while the final hosts are all domestic animals and man (Dunn, 1978). After eggs are laid by females they hatch in minutes and the

miracidia penetrate the appropriate snail. The miracidium develops to sporocyst stage inside the snail, which develops to daughter sporocysts and then to cercariae which act as the infective stage. Penetration of the final host occurs by motile cercariae and they lose their bifurcated tails and transform to schistosomula (young flukes) which travel via blood stream to the heart and lungs and to the systemic circulation. In the liver they locate in the portal veins and become sexually mature before migrating to the final site. The prepatant period is 6–7 weeks (Soulsby, 1982). Malek (1969) suggested that *S. matthei* might occur in southern region of Sudan, *S. bovis* infection was recorded in cattle and sheep causing heavy economical loss (Eisa and Alkhawad, 1978). The parasite was also shown to occur in the western and eastern parts of the country (Malek, 1969; Hussein, 1973; Elbadawy and Slepnov, 1976).

1.1.3.3 *Taenia* species

The genus is parasitic in carnivores and man. The most important species of this family are *T. saginata* and *T. solium*, for which man acts as a final host. The intermediate host of *T. saginata* is the ox, while pig and man are intermediate hosts of *T. solium*. *Cysticercus bovis* is the infective stage of *T. saginata*, whereas *Cysticercus cellulosae* is the infective stage for *T. solium*. The larval predilection site for both are muscles (Dunn, 1978).

The transmission of taeniasis is by ingestion, the larva usually reaches its full infective form 2-3 months from ingestion by the intermediate host, while the final host is infected after ingesting tissues containing larvae.

1.2 Blood parasites

1.2.1 *Theileria* species

1.2.1.1 Definition and classification

Theileria is a blood protozoan parasite which occurs throughout the world (FAO, 1987). Soulsby indicated that, the parasites are round, ovoid, rod-like or irregular forms, found in lymphocytes, histocytes and erythrocyte. The African buffalo acts as a reservoir host for *Theileria* infection to domestic animals, (Neitz, 1955-1957). The classification of the genus *Theileria* according to the revision of the Committee on Systematic and Evolution of the Society of Protozoologist (CSESP) which was published by Levine *et al.* (1980) is as follows:

Kingdom	<i>Animalia</i>
Subkingdom	<i>Protozoa</i>
Phylum	<i>Apicomplexa</i>
Class	<i>Sporozoea</i>
Subclass	<i>Piroplasmida</i>
Family	<i>Theileridae</i>
Genus	<i>Theileria</i>

1.2.1.2 Transmission of theileriosis

The disease is transmitted by tick species of the genus *Hyaloma* (Koch, 1906); Siddig (1992) proved that *Amblyoma* and *Rhipicephalus spp* can transmit the disease. According to Doubovy (1982), transmission occurs when there is a metamorphosis of the tick between feeding on an infected animal and feeding on a susceptible one.

Most of the ticks which are considered as vectors for tropical theileriosis undergo a two or three host life cycle (Bhattacharyulu *et al.*, 1975).

1.2.2 *Babesia* species

1.2.2.1 Description and classification

The organisms of the family *Babesiidae* are round to pyriform, or amoeboid forms, occurring in the erythrocytes. They multiply by budding, their vectors are ticks (Soulsby, 1982). According to Levins *et al.* (1980), the classification of *Babesia* is:

Kingdom	<i>Animalia</i>
Subkingdom	<i>Protozoa</i>
Phylum	<i>Apicomplexa</i>
Class	<i>Sporozoea</i>
Subclass	<i>Piroplasmida</i>
Family	<i>Babesiidae</i>
Genus	<i>Babesia</i>

1.2.2.2 Transmission of *Babesia* species

In tropical production system, babesiosis is mainly transmitted by *Boophilus* spp. the blood forms of *Babesia* can be transmitted by mechanical means from infected animals to susceptible ones, and these then initiate a further cycle of asexual reproduction. On the other hand development and transmission of *Babesia* spp. in ticks is either by Trans-ovarian or by stage to stage transmission Soulsby (1982).

1.2.3 *Trypanosoma* species

1.2.3.1 Description and classification

Trypanosomes are microscopic elongated unicellular flagellates which move forward with the help of a single flagellum which arises from a characteristic structure, the flagellar pocket near the kintoplast, situated at the posterior end of the cell. They are obligate parasites that multiply in the body fluids, especially blood stream and tissue fluids of the vertebrate host, and live in the digestive tract of the invertebrate host which is generally a biting fly (Itard, 1981).

Hoare (1957, 1964) proposed a classification of the mammalian trypanosomes into two sections: the *Sarcorarria* and the *Salivaria*. Classification of pathogenic trypanosomes of veterinary importance is presented by Levine (1980) as follows

Kingdom	<i>Animalia</i>
Subkingdom	<i>Protozoa</i>
Phylum	<i>Sarcomastigophora</i>
Class	<i>Zoomastidophora</i>
Order	<i>Kinetoplastida</i>
Suborder	<i>Trypanosomatina</i>
Family	<i>Trpanosomatidae</i>
Genus	<i>Trypanosoma</i>

1.2.3.2 Transmission of trypanosomes

The species of the *Trypanosoma brucei* group, *T. vivax* and *T. congolense* live in the blood and intercellular space of the tissue of mammalian host. These trypanosomes are transmitted cyclically by adult

stage of the tsetse fly, during the cycle they undergo several morphological changes which correlate with the physiological changes in the host and vector (Mulligan, 1970 and Hajduk *et al.*, 1992).

On the other hand, in mechanical transmission, trypanosomes are transmitted during intermittent feeding of biting flies mainly in infected and non-infected animals (Soulsby, 1982). Animal trypanosomiasis in Northern Sudan is believed to be transmitted mechanically by biting flies other than *Glossina*, e.g. *Tabanidae*, *Stomoxys* (El Karib, 1961; Yagi and Abdel Razig, 1972). Evans (1948, 1950) and El Karib (1961) reported the presence of *T. vivax* and *T. congolense* outside the tsetse belts in Sudan.

1.3 Diagnosis

1.3.1 Diagnosis of internal parasites

Laboratory diagnostic methods of the parasitic infection have two objectives (King, 1979):

1. To identify the causative agents.
2. To estimate the intensity of the infection.

1.3.1.1 Gross examination

Feecal samples should be examined for any intact specimens such as *Moniezia* spp. segment and *Oesophogostomum* species adults. Examination of the smear only indicates the presence of infection regardless of its quantification (Dunn, 1978).

1.3.1.2 McMaster Technique

Mc Master Technique depends on the examination of a precise volume of suspension of faeces in floatation solution, to allow an estimation of the

number of eggs and larvae present in a sample. The natures of solution vary according to the animal origin of the suspected material and mixing performed in various ways. The essential equipment is a slide that consists of two layers of glass separated by a known distance and having on the upper layer a ruled square of known area (King, 1979).

1.3.1.3 Concentration methods

Concentration depends on specific gravity of the eggs and is not reliable in estimating the intensity of an infection, and can be achieved by sedimentation or floatation (King, 1979).

1.3.1.3.1 Sedimentation

The parasite eggs do not float, but deposit in the solution either by slow natural precipitation of faecal suspension or by the use of centrifugation. This method is relevant to fascioliasis, schistosomiasis and paramphistomiasis (King, 1979).

1.3.1.3.2 Flotation

In this method the specific gravity of the solution is higher than the specific gravity of the eggs. Thus the solution used is at saturation or semi-saturation such as sodium chloride and sugar (sucrose). The method is used for strongylids, *Metastrongylus* spp. and *Ascaris* spp.

1.3.2 Diagnosis of blood parasites

Diagnosis of blood parasites is based on the clinical signs and confirmed by the detection of parasites in the peripheral blood. A stained thin blood film is commonly used for diagnosis of blood parasite (Soulsby 1982).

Goel and Singh (1971) explained that wet mount is more suitable for examination of the motility of *Trypanosoma* spp. Woo (1970) stated that the microhaematocrit centrifugation and examination of the buffy coat is sensitive for detection of *Trypanosome* spp when the parasitaemia is low.

Soulsby (1982) explained that the most satisfactory diagnosis of theileriosis is made by the demonstration of schizontes in materials obtained from superficial lymph nodes or by spleen puncture.

Serological methods have been used for presence of antibodies or antigens against blood parasite. The most common serological tests that were used are: Complement Fixation Test (CFT) (Schoening, 1924 and Sabanshiev, 1975), Indirect Haemagglutination Test (IHAT) (Jatkar and Singh, 1971), immunoperoxidase test, Indirect Immunofluorescent antibody Test (IFAT), Enzyme Linked Immunosorbent Assay (ELISA) and Capillary Tube Agglutination Test (CTAT) (Sabanshiev, 1973; Molyneux, 1975, Luckins, Gray and Rae, 1978, 1978; Wilson, 1969).

Techniques for the detection of parasite DNA have a high sensitivity and specificity when coupled with amplification of the DNA by the Polymerase Chain Reaction (PCR) (von Samson-Himmelstjerna *et al.*, 2002).

1.4 The epidemiology of internal and blood parasites of dairy cattle in Sudan.

Saad (2004) investigated the diseases in dairy cows in The White Nile and Gezira States. He stated that the most common blood and internal parasites were babesiosis, trypanosomiasis, theileriosis, fascioliasis, schistosomiasis, paramphistomiasis, moniziasias and taeniasis.

There are two important species of *Babesia* infecting cattle in the Sudan, *B. bovis* and *B. bigemina*. Minor outbreaks of *B. bovis* were reported to occur from time to time in endogenous breeds (Jongejan *et al.*, 1987). An investigation by the FAO (1983) indicated that *B. bigemina* was found to be a minor cause of economic losses in Sudan.

Bovine trypanosomiasis is regarded as one of the major enzootic disease of cattle in Sudan (Karib, 1961 and Hall *et al.*, 1983 and 1984). The prevalence of the disease and its vectors had been investigated by several workers (Yagi and Abdel Razig, 1972 and Hall *et al.*, 1984) there are four species of theileriosis reported in Sudan (FAO, 1983), those included *T. annulata*, *T. parva*, *T. mutans* and *T. hirci*. *T. annulata* in particular is considered as a major obstacle to the development of livestock industry in Northern Sudan (Osman, 1990). Also the infection of *T. annulata* was detected in 37% of apparently healthy cattle in River Nile State in Northern Sudan; the prevalence rate was higher in adult cross breed than in endogenous cattle (Hussein *et al.*, 1991).

1.5 Economic impact of parasitism

1.5.1 Economic impact of internal parasites

Reports from several tropical countries indicated that infection with gastro-intestinal parasites may cause clinical disease with high mortality among farm animals of all species with consequent impact on production. Furthermore the same reports stressed that the gastro-intestinal nematodes are of considerable economic importance causing clinical disease with mortalities but more importantly by causing chronic production losses as a result of reduced weight gain, weight loss and

reduced milk production. The same impact had been reported for the liver fluke, of animal in tropical production system (FAO, 2005).

Echinococcosis and Taeniasis have public health significance due to their zoonotic importance (FAO, 2005).

1.5.2 Economic impact of blood parasites

Many researchers conducted studies on the economic importance of blood parasites infections of cattle.

Animals affected with trypanosomiasis were chronically unproductive in terms of milk, meat and the mortality rate could be high. Tsetse flies infest 10 million square kilometers of Africa involving 37 countries, so that the control programs were too difficult and expensive which is estimated to cost in cattle alone more than 500 millions US dollars each year (Radostits, *et al.*, 2000). Furthermore, trypanocidal drugs available for disease treatment and prevention are very limited in number (Williason, 1970; Leach and Roberts, 1981). Bauer *et al.* (1999) stated that African Animal Trypanosomiasis caused reduction in milk production and fertility. Pholpark *et al.* (1999) suggested that subclinical trypanosomiasis caused reduction in milk yield.

Theileriosis is the major constraint for livestock improvement programs in many parts in The Middle East and Asia (Hashemi-Fesharki, 1988) and about 200 millions cattle are at risk (Hall, 1988). Moreover, Gitau *et al.* (2001) recorded that there are great association between *Theileria* species infection and daily weight gain in calves. Michael *et al.* (1989) reported that the treatment of chronic theileriosis with buparvaquone increase milk

yields, so there was a significant economical effect due to reduction in milk yield of infected cattle.

Bovine babesiosis had high economic importance due to the direct losses of milk and meat production. Many animals died or had a long period of convalescence with an initial loss of production. Incidental costs of immunization and treatment add to economic burden, in addition to the high cost of tick control (Radostits, *et al.*, 2000). Hofmann-Lehmann *et al.* (2004) studied the concurrent infections with vector-born pathogens associated with fatal hemolytic anemia in a cattle herd in Switzerland; he suggested that *Theileria* spp. and *Babesia* spp. Infection cause an enormous effect on cattle productivity by causing haemolytic anaemia.

1.6 Control

Control of parasitic diseases can be achieved by elimination of the parasites using chemotherapy, either by control of vectors for blood parasites or intermediate hosts of internal parasites.

1.6.1 Blood parasites

Control of blood parasite can be achieved by controlling the parasite through chemotherapy and controlling the vectors. The available trypanocidal drugs are used for treatment and prevention of trypanosomiasis these include the following compounds:

Homidium, isometamidium chloride, diminazine aceturate, suramin and cymelarsan (Williason, 1970; Leach and Roberts, 1981; Denning *et al.*, 1989).

Buparvaquone is the most effective agent for treatment of theileriosis, while chemoprophylaxis with imidocarb is commonly used for babesiosis (Radostits *et al.*, 2000).

The most important and widely used methods of controlling tsetse transmitted human and animal trypanosomiasis are:

Ground spraying, residual insecticide spraying, sterilized male insects and traps used with or without insecticide. The control of ticks can be attained by regular dipping or spraying the animal using the insecticides, pasture spelling, vaccination and use of resistant cattle (Radostits *et al.*, 2000).

1.6.2 Internal parasites

Fischer and Say (1989) explained that the control of gastrointestinal parasites depends mainly on drug prophylaxis for eliminating the parasites by regular treatment as follows:

1. The animal should be given antihelmentics at the end of the rainy season in order to improve the adaptation of the animal to harsh dry season conditions.
2. Another treatment by antihelmentics should be given at the end of the dry season so that the infection of pasture by parasites at the time of the first rains can be reduced.

On the other hand, Thursfield (1996) described that the level of infection with some nematodes can be reduced by mixed, alternate and sequential grazing.

CHAPTER TWO

MATERIALS AND METHODS

2.1 Area description

The study was conducted in Khartoum State which is situated in Northern Sudan between latitude 15° 38'N and longitude 32° 26'E. It is regarded as an area of intensive dairy production system and small farms holders of dairy in the country. Indigenous breeds as well as foreign European breeds of cattle together with a range of crossbred animal are common.

The total area extends over approximately 21,000 square kilometers. The climate of Khartoum is an arid type which is characterized by a wide range in daily and seasonal temperatures. During cool season between December to February the weather is cool and dry with a mean daily temperature of 24°C. The season is characterized by low humidity. A hot dry weather prevails between March to October, a temperature of 45°C may occur during the day. The maximum rainfall is during the period from mid July to mid September, in this season there is an increase in relative humidity with a maximum of 68% in August (Sudan Metrological department, 1995). It is more convenient to divide the year into a cool dry season, hot dry season and hot wet season.

2.2 Sampling

Kuku area is regarded as one of the most important sites of semi-intensified production system of milk production in Khartoum state. For this reason it was selected for the study. Selection of the farms was done according to the willingness of the owners. This sampling method is called non-probability sampling method (convenience sampling) as

described by Thrusfield (1996). Within the selected farms the number of animals was taken as in small farms all the herd was sampled and 10% of the herd was sampled from big farms. The detailed number was as in table (2.1).

The size of the farms was decided as:

1. Small farms of 7-13 animals.
2. Big farms of over 13 animals. The sample size constituted a 100 animals from 10 farms.

2.3 Study population

Cattle in dairy farms of Kuku area were sampled. The same herds were investigated in the different seasons. At the dry cool season a total of 100 animals were examined.

2.4 Blood sample collection

Blood samples were collected in the morning randomly from the jugular vein of cattle in different ages using vacutainer with EDTA. Data on age, breed, sex and temperature were recorded. Samples were placed in an ice box at 4°C and transferred as soon as possible to the laboratory before processing for parasitological examination.

The cross-breed composed 98% (n= 98) of the sample while local breeds composed 2% (n= 2). The same percentage was recorded for sex, females being 98% (n= 98) and males 2% (n= 2). Cattle were grouped into three age groups namely 0-3, 4-6 and over 6 years at a percentage of 7%, 64% and 29%, respectively (Table 2.2). The sample collection continued over three season of the year dry cool (February-March), dry hot (May-June) and wet hot (August-September) from the same animal.

Table (2.1) Samples selection from dairy farms in different season in Kuku area

Farm No.	Total No. of animals	Number of animals sampled			Total samples collected
		Dry cool	Dry hot	Wet hot	
1	7*	7	5	5	17
2	10*	10	10	10	30
3	13*	13	13	13	39
4	55**	6	3	3	12
5	68**	7	7	7	21
6	88**	9	9	9	27
7	89**	9	9	9	27
8	110**	11	11	11	33
9	130**	13	13	11	37
10	150**	15	15	10	40
Total:	720**	100	95	88	283

* All animals were included in the sample collection.

** 10% were included.

Table (2.2) Description of the study population in Kuku area

<u>Unit</u>	<u>Season</u>		
	Dry cool	Dry hot	Wet hot
	Frequency (%)		
Total number of animals examined	100	95	88
Breed			
1. local breed	2(2.00)	2(2.11)	2(2.27)
2. cross breed	98(98.00)	93(97.89)	86(97.73)
Sex			
1. male	2(2.00)	2(2.11)	2(2.27)
2. female	98(98.00)	93(97.89)	86(97.73)
Age (year)			
1. 0-3	7(7.00)	6(6.32)	4(4.55)
2. 4-6	64(64.00)	47(49.47)	44(50.00)
3. > 6	29(29.00)	42(44.21)	40(45.45)

2.5 Faecal samples collection

Fresh faecal sample were collected from the rectum of individual animals in plastic bags. The bags were labeled and immediately transferred to the laboratory for faecal examination.

2.6 Collection of ticks

Ticks were collected from individual animal and counted according to the intensity of the ticks namely >5 ticks/animal (low infestation), 5-20 ticks/animal (moderate infestation) and <20 ticks/animal (high infestation).

2.7 Parasitological examination

2.7.1 Wet blood mount:

One drop of fresh blood was placed on a slide, covered with a cover-slip and examined microscopically for detection of motile parasites at 10×40 magnification.

2.7.2 Buffy coat examination:

Buffy coat examination was done using capillary tubes centrifuged for five minutes in a haematocrit centrifuge. The capillary tubes were place onto a clean slide and cover with one drop of distilled water, then examined microscopically at 10×40 magnification to detect trypanosomes and microfilariae (Woo, 1970).

2.7.3 Packed Cell Volume (PCV)

The capillary tubes which were spun in a haematocrit centrifuge were taken and put into the haematocrit reader to record the PCV.

2.7.4 Thin blood film:

Thin blood films were prepared on slides, dried and fixed with absolute alcohol. They were then stained with 5% diluted Giemsa's stain solution for 45 minutes. Stained blood films were washed using distilled water, air dried and examined microscopically at 10×100 magnification for detection of blood parasites.

2.7.5 Faecal examination

2.7.5.1 Flotation method

Two to three grams of the faeces were taken in a mortar. The samples were then covered with saturated sodium chloride solution. The solution was poured through a tea sieve into a beaker to remove the large particles. Some of the solution was poured into a small bottle until it was completely filled to make a convex meniscus at the top, then it was covered with a clean grease-free cover slide. The slide was removed after 10 minutes and placed on a slide and examined under Low power ×20 magnifications. The examination was done systematically to cover all the covers lip.

2.7.5.2 Sedimentation

Two to three grams of the faeces were mixed with water and put in tubes. The tubes were centrifuged using low centrifugation for 5 minutes for three times. The deposits were taken and placed onto slides with coverslips and examined microscopically at low power ×40 magnifications for detection of the eggs.

2.8 Data analysis

Microsoft excel (windows 2003) and stata 6.0 for windows 98/95/NT were used for data analysis. Chi-square (χ^2) was used for assessing the statistical associations of various factors for presence of blood and internal parasites. Logistic regression model was employed to obtain the odds ratio (OR) only for those factors which gave statistical significant by using chi-square (χ^2).

If the odds Ratio was greater than one the factor could be a risk factor for the presence of blood or internal parasites.

CHAPTER THREE

RESULTS

The results of this study conducted on dairy herds in Kuku area to investigate the presence of the blood and internal parasites in different seasons, and the effect of age and sex showed that the prevalence of blood parasites was 46% (n= 100), 14.74% (n= 95) and 5.68% (n= 88) in the dry cool, dry hot and wet hot seasons, respectively. Fifteen percent, 8.42% and 11.36% were recorded to harbour internal parasites in the dry cool, dry hot and wet hot season, respectively (Table 3.1). Mixed infection of where was found in 7% and 1.13% in the dry cool and wet hot seasons, respectively, while there was no mixed infection in the dry hot season (Table 3.2)

High prevalence of *Theileria* species infection was reported in the dry cool season (39%) compared to dry hot and wet hot seasons (14.74% and 5.68%, respectively). In contrast, prevalence of *Babesia* species infection and Filarial worm infection were only recorded in the dry cool season (6% and 1%, respectively) (Table 3.3). On the other hand, *Coccidia* species infection was observed in different seasons at a prevalence of 6%, 3.16% and 5.68% for the dry cool, dry hot and wet hot season, respectively. High prevalence of *Fasciola* species infection (7%) was reported in the dry cool season; while high prevalence of *Schistosoma* species infection (5.26%) was reported in the dry hot season. The results are shown in table (3.4).

A positive correlation ($\chi^2= 48.483$, $P< 0.01$) was found between season and presence of blood parasites. However, the Odd Ratio (OR= 0.244) indicated that the season could not be a risk factor for infection with

Table (3.1): The summary of the results of blood and internal parasites survey in dairy farms among different season in Kuku area

<u>Unit</u>	<u>Season</u>		
	Dry cool	Dry hot Frequency (%)	Wet hot
Total no. of animal examined	100	95	88
Packed Cell Volume (PCV)			
1. normal	20(20.00)	29(30.53)	18(20.45)
2. abnormal	80(80.00)	66(69.47)	70(79.55)
Tick infestation			
1. mild	51(51.00)	93(97.89)	87(98.86)
2. moderate	49(49.00)	2(2.11)	0(0.00)
3. high	0(0.00)	0(0.00)	1(1.14)
Blood parasites			
1. positive	46(46.00)	14(14.47)	5(5.68)
2. negative	54(54.00)	81(85.26)	83(94.32)
Internal parasites			
1. positive	15(15.00)	8(8.42)	1(11.36)
2. negative	85(85.00)	87(91.58)	78(88.64)

Packed Cell Volume (PCV): Adult cow: normal 28.4-38.8 Calf: normal 32.0-39.7

Table (3.2) The prevalence of blood parasites, internal parasites and mixed infections in different seasons in dairy cattle in Kuku area

<u>Parasitic infection</u>	<u>Season</u>		
	Dry cool	Dry hot Prevalence (%)	Wet hot
Internal parasites	10.00	9.47	10.22
Blood parasites	38.00	8.42	4.54
Mixed infection	7.00	0.00	1.13

Table (3.3): The prevalence of blood parasites among different seasons in dairy farms in Kuku area

Season	No. of animal examined	<u>Prevalence (%)</u>			Over all prevalence
		<i>Theileria</i> spp.	<i>Babesia</i> spp.	Microfilaria	
Dry cool	100	39.00	6.00	1.00	46.00
Dry hot	95	14.74	0.00	0.00	14.74
Wet hot	88	5.68	0.00	0.00	5.68

Table (3.4): The prevalence of internal parasites among different seasons in dairy farms in Kuku area

Season	No. of animal examined	<u>Prevalence (%)</u>				Over all prevalence
		<i>Coccidia</i> spp.	<i>Fasciola</i> spp.	<i>Schistosoma</i> spp.	<i>Paramphistomum</i> spp.	
Dry cool	100	6.00	7.00	1.00	1.00	15.00
Dry hot	95	3.16	0.00	5.26	0.00	8.42
Wet hot	88	5.68	4.55	1.14	0.00	11.36

blood parasites (Figure 3.1). In contrast, there was no relationship ($\chi^2 = 2.058$, $P > 0.05$) between the season and occurrence of internal parasites (Figure 3.2). The age was found associated ($\chi^2 = 6.211$, $P < 0.05$) with the presence of blood parasites. However, the application of logistic regression model indicated that the age could not be a risk factor for infection with blood parasites (Odd Ratio (OR) = 0.643) (Table 3.5 and 3.6).

A positive correlation ($\chi^2 = 20.583$, $P < 0.01$) was obtained for tick infestation with regard to the presence of blood parasites. This was confirmed by the result of Odd Ratio (OR = 3.586) which revealed that the tick infestation could be a risk factor for infection of blood parasites (Table 3.5 and 3.6).

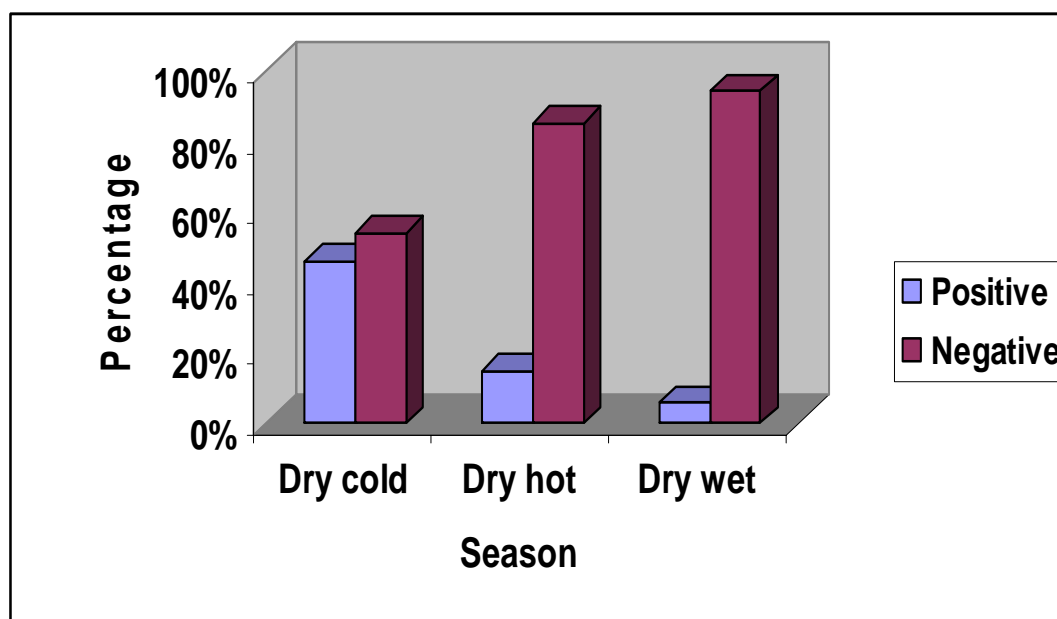
A strong relationship ($\chi^2 = 9.679$, $P < 0.01$) was recorded between infection with the blood parasites and Packed Cell Volume (PCV). The same results was confirmed by the Odd Ratio (OR = 1.717) which indicated that infection of blood parasites could be a risk factor for PCV (Table 3.5 and 3.6).

Statistical analysis of breed and age with respect to presence of internal parasites indicated that there was no relationship ($\chi^2 = 0.149$, $P > 0.05$ and $\chi^2 = 2.475$, $P > 0.05$) (Table 3.7).

Sex was found associated with presence of internal parasites ($\chi^2 = 8.747$, $P < 0.01$). However, sex could not reach the level of risk factor for occurrence of internal parasites (Odd Ratio (OR) = 0.121) (Table 3.7 and 3.8).

The infection of internal parasites was found to be strongly correlated ($\chi^2 = 6.573$, $P < 0.05$) with the Packed Cell Volume (PCV). The same result was obtained for Odd Ratio (OR) = 3.582 which indicated that the infection of internal parasites could be a risk factor for PCV.

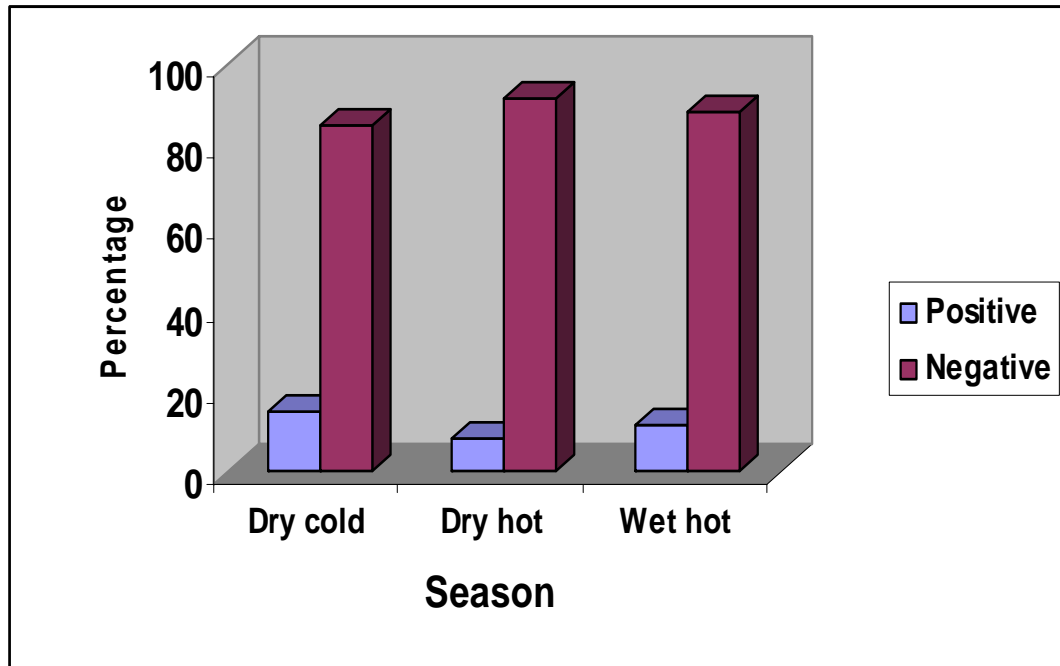
Figure (3.1): The effect of season on presence of blood parasites in dairy farms in Kuku area



Chi-square (χ^2) = 48.483 P -value = 0.000 (highly significant, $P < 0.01$)

Odd Ratio (OR) = 0.244 (OR < 1, could not be a risk factor for presence of blood parasites).

Figure (3.2): The effect of season on presence of internal parasites in dairy farms in Kuku area



Chi-square (χ^2) = 2.058

P -value = 0.357 (not significant, $P > 0.05$).

Table (3.5): The association between occurrence of blood parasites and various factors in dairy farms in Kuku area

Factor	Chi-square (χ^2)	<i>P</i>-value
Breed	0.138	0.711
Sex	0.372	0.542
Age	6.211	0.045*
Tick infestation	20.583	0.000**
Packed Cell Volume (PCV)	9.669	0.008**

* Is significant difference ($P < 0.05$) while ** is highly significant difference ($P < 0.01$).

Table (3.6): Logistic regression model selected to demonstrate association between occurrence of blood parasites and some factors in dairy farms in Kuku area

Factor	SE	OR	95% CI
Age	0.156	0.643	0.400-1.034
Tick infestation	1.147	3.586 *	1.915-6.713
Packed Cell Volume (PCV)	0.574	1.717 *	0.892-3.304

SE: Standard Error OR: Odd Ratio CI: Confidence Interval

* refer to $OR > 1$ and could be a risk factor for presence of blood parasites.

Table (3.7): The association between occurrence of internal parasites and various factors in dairy farms in Kuku area

Factor	Chi-square (χ^2)	<i>P</i>-value
Breed	0.149	0.699
Sex	8.747	0.003**
Age	2.475	0.290
Packed Cell Volume (PCV)	6.573	0.037*

* Refer to significant difference ($P < 0.05$) while ** refer to highly significant difference ($P < 0.01$).

Table (3.8): Logistic regression model selected to demonstrate association between occurrence of internal parasites and some factors in dairy farms in Kuku area

Factor	SE	OR	95% CI
Sex	0.102	0.121	0.023-0.629
Packed Cell Volume (PCV)	1.852	3.582*	1.300-9.868

SE: Standard Error OR: Odd Ratio CI: Confidence Interval

* refer to $OR > 1$ and could be a risk factor for presence of blood parasites

CHAPTER FOUR

DISCUSSION

The results of this study showed that infection with blood and internal parasites were common in the selected dairy herds in the study sites (46% and 15% at the (dry cool season) for blood and internal parasites, respectively) similarly, investigations on blood and internal parasites in different production system in Sudan had been made by different workers. Saad (2004) stated that *Theileria*, *Babesia*, and *Microfalaria* were prevalent in dairy farms in the White Nile and Gezira States (6.4% and 4%, for Theileriosis, 4.8% and 1.6% for Babesiosis, 4.8% and 1.6% for *Microfalaria*). El Hussein *et al.* (1991) recorded *Theileria annulata* infection in 37% of apparently healthy cattle in River Nile state Northern Sudan. he also found that the prevalence of infection was higher in adult cross-bred compared to indigenous cattle. Jongejan *et al.* (1987) indicated that several minor outbreaks of *Babesia bovis* were reported to occur from time to time in local breeds in the Blue Nile State.

Presence of blood parasites in the study area was most likely attributed to the management. From an epidemiological point of view, husbandry and general condition in dairy farms were strongly associates with the presence of both infectious and non-infectious diseases. It was observed that the tick infestation was one of the great problems in dairy farms in Kuku area due to lack of application of proper management practices and misuse of acaricides. Moreover, the pens were poorly designed made of mud and metals which constitute a place and source of ticks infestation. It was also observed that there was no routine screening for blood parasites or prophylactic use of anti-protozoal drugs in study site.

On the other hand, infection with internal parasites was well documented from different production systems of Sudan. An investigation of diseases in dairy cattle in the White Nile and Gezira States by Saad (2004) revealed the prevalence of fascioliasis at 34.4% and 14.4% in the two states, while paramphistomiasis prevalence was 40% and 17.6%. In addition the same author recorded low prevalence of schistosomiasis (4%) in the White Nile area, but he did not detect in dairy farms in Gezira state. Eldoush (1995) reported the presence of *Fasciola gigantica* (7.4%) and *Schistosoma bovis* (0.2%) in faecal samples collected from the slaughter-house in Atbara.

The presence of internal parasites in cattle of Kuku area is mostly due to poor hygiene in the farms resulting from infrequent removal of animal dung noting that the animals were crowded in the center of pens where there was a partial shade. Further more, the animals were fed fodder contained of internal parasites from endemic area which increases the risk of infection with internal parasites as contamination with infective stages can happen at any point. It was observed in Kuku dairy farms that there was continuous introduction of new animals particularly from areas which are known to be endemic for schistosomiasis and fascioliasis such as Gezira and White Nile areas.

Our study revealed that there was no correlation between season and occurrence of internal parasites ($X^2 = 2.058$, $P > 0.05$). This finding disagrees with Fischer and Say (1989), who stated that the out break of internal parasites animals were associated with the dry season and the beginning of the rainy season. Based on that, they recommended treatment of animals with antihelmentics both at the end of the rainy season and the end of the dry season. This difference in the results

obtained by the two workers might be attributed to the type of production system as most of the studies on the effect of the season on the prevalence of internal parasites had been done in pastoral production system. This study was conducted on intensive production system where the environmental condition and feeding are not subjected to distinct changes throughout the year.

As seen from the result, there was no significant association observed between to the breed and the infection with internal parasites. In contrast, from an epidemiological investigation conducted in dairy farm in Uganda (Magona and Mayende, 2002), indicated that infection with *Fasciola* and gastrointestinal nematodes was higher in exotic breeds compared to the local breeds (Zebu and Sahiwal). Moreover, Duval (1997) explained that an animal which had never been exposed to infection with worms can not develop resistance and immunity against their infection. Local breeds have a high ability to prevent or limit establishment or subsequent development of worms infection due to the long previous continuous exposure to the infection with internal parasites. In this study, most of cattle examined (98%) were cross-bred and this might have affected the outcome of statistical analysis.

A significant correlation ($\chi^2 = 8.747$, $P < 0.01$) was obtained in this study sex and the occurrence of internal parasites, although it did not reach the level of risk factor. This result is in contrast with the finding of El Doush (1995) who recorded that there was no correlation between the sex of the animal and preference regarding the presence of liver and gastrointestinal parasites of cattle at Atbara. That might be because the study was conducted in animals brought for slaughtering not in dairy farms. There is another effect due to the sample size as described by Thrusfield

(1996), who explained that in cross-sectional studies there is no evidence that the factor is strongly associated with the occurrence of disease when the sample size is low (the total population of the cattle was 100 at the beginning of our study).

Negative association was obtained for age with respect to the presence of internal parasites ($\chi^2 = 2.475$, $P > 0.05$). This result is completely in contrast with Duval (1997) who, stated that the age as well as weight of animals determine susceptibility to parasites. Young animals do not have a great deal of immunity to parasites during the first year in the pasture. His study also revealed that adult animals are much less susceptible to most parasites, unless they are in poor living condition. Most of the animals examined in this study are females of more than three years of age (93%), this may have affected the correlation between age and infection rates.

A close correlation was recorded for packed cell volume (PCV) and presence of internal parasites ($\chi^2 = 6.573$, $P < 0.05$, $OR = 1.852$). This finding has been previously confirmed by Magona and Mayende (2002). They reported high percentage of anemia in exotic breed (Friesian) compared to the local breed (Zebu and Sahiwal) due to the infection with both blood and internal parasites during his investigation in dairy farms in Uganda.

This study revealed a positive correlation between season and infection with blood parasites ($\chi^2 = 48.483$, $p < 0.01$). However, the season did not reach to the level of risk factor ($OR = 0.244$). The same finding was confirmed by Al-Mentenawy (2000) during his investigation concerning the presence of blood parasites in Qassim region (Saudi Arabia). He

reported that the infection with *Theileria annulata* was high in both autumn and summer, while it decreased in spring. It was suggested that the environmental factors in grazing season might influence the maturation of parasites in salivary glands of ticks (Kamio *et al.*, 1990).

The breed was not found to be associated with infection of blood parasites ($\chi^2 = 0.138$, $p > 0.05$). This could be attributed to the low number of indigenous cattle examined most of the cattle population in dairy farms in Kuku area was of cross breeds (98%). The result disagrees with Bock *et al.* (1997, 1999), who investigated the effect of the cattle breed on the transmission rates and innate resistance to *Babesia* species. He observed that cross-bred showed a maximum depression in Packed Cell Volume (PCV) due to infection with *Babesia* species, while pure-bred cattle have a high degree of resistance to babesiosis. Another research from Costa Rica (Perez *et al.*, 1994) indicated that the breed was determined as risk factor in the sero-prevalence of *Anaplasma marginale* and *Babesia bovis*.

As seen from the result, the age was correlated with the occurrence of blood parasites ($\chi^2 = 6.211$, $p < 0.05$). The same result was obtained from Latif *et al.* (1979) who stated that in calves of 3, 6, 12 and 18 months age the presence of *Babesia* infection was demonstrated, while in calves more than 22 months no parasites could be demonstrated. Perez *et al.* (1994) also reported that cattle (over one year) as well as calves less than one year were highly susceptible to Anaplasmosis and Babesiosis. Moreover, Ahmed (1997) reported that the infection with tropical theileriosis was higher in calves rather than adult cattle among the cattle admitted to the National Veterinary Teaching Hospital, Khartoum during the period 1990-1995.

A strong relationship was found between tick infestation and presence of blood parasites ($\chi^2= 20.583$, $p< 0.01$). The result also revealed that the tick infestation could reach the level of risk factor (OR= 3.586). Similarly, Gomes *et al.* (1994) found a significant association between the presence of ticks and infection with *Protozoa* and *Rickettsiae*.

A strong correlation was also obtained for Packed Cell Volume (PCV) with regard to occurrence of blood parasites ($\chi^2= 9.679$, $p< 0.01$). A study by Shiono *et al.* (2004) indicated that anemia is the most important clinical manifestation in cattle infected with *Theileria* species. Another author Gill *et al.* (1997) confirmed that anemia and jaundice were regarded as the major pathological change occurring due to *Theileria annulata* infection.

Based on results of this study it could be concluded that infection with both blood and internal parasites were prevalent in dairy farms in Kuku area. There was a positive association between season and presence of blood parasite. While, there was no correlation obtained for infection with internal parasite. Tick infestation was considered to be a risk factor for blood parasite infection. Anaemia is the most important features, as measured by PCV value, for infection with internal and blood parasites and it may lead to reduce animal productivity.

It is hence recommended that good managements, adequate nutrition and improvement of the general condition in the dairy farms are required in order to avoid parasitic infections. Ticks infestation should be controlled using proper management practices and periodic application of acaricides in order to reduce blood parasitic infections. More investigation would be required to clarify the relationship between the presence of internal

parasites and seasons. An attempt should be made to increase the awareness of the dairy farms owners regarding the economic impact of parasitic infections.

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